AMERICAN SOCIETY FOR TESTING MATERIALS
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Tentative Specifications for
STANDARD STRENGTH PERFORATED CLAY PIPE[1]

A.S.T.M. Designation: C 211 - 47 T

Issued, 1947.[2]

These Tentative Specifications have been approved by the sponsoring committee and accepted by the Society in accordance with established procedures, for use pending adoption as standard. Suggestions for revisions should be addressed to the Society at 1916 Race St., Philadelphia 3, Pa.

Scope

1. These specifications cover standard strength perforated clay pipe intended to be used for underdrainage.

Class

2. Pipe manufactured according to these specifications shall be known as "Standard Strength Perforated Clay Pipe."

Materials and Manufacture

Materials and Manufacture

3. (*a*) Clay pipe shall be manufactured from surface clay, fire clay, or shale, or a combination of these materials.

(*b*) Surface clay is an unconsolidated, unstratified clay,[3] occurring on the surface.

(*c*) Fire clay is sedimentary clay[3] of low flux content.

Note.—Fire clay is usually associated with coal measures.

(*d*) Shale is a thinly stratified, consolidated, sedimentary clay[3] with well-marked cleavage parallel to the bedding.

(*e*) These materials or any combination thereof, when molded into pipe and subjected to suitable temperatures, shall yield a product that will be strong, durable, serviceable, free of objectionable defects, and shall conform to these specifications.

Resistance to Action of Acids

Tests at Purchaser's Option

4. Tests for resistance to action of acids shall be optional with the purchaser, and shall be made only when specified by him in advance or in the "call for bids." The purpose of this test is to determine the resistance of pipe to the action of acids.

Reagent

5. When testing with either hydro-

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[1] Under the standardization procedure of the Society, these specifications are under the jurisdiction of the A.S.T.M. Committee C-4 on Clay Pipe.

[2] Accepted by the Administrative Committee on Standards, September 4, 1947.

[3] The definitions for the terms "surface clay," "fire clay," and "shale" are based on the following definition for the term "clay":

Clay.—An earthy or stony mineral aggregate consisting essentially of hydrous silicates of alumina, plastic when sufficiently pulverized and wetted, rigid when dry, and vitreous when fired at a sufficiently high temperature.

chloric, nitric, sulfuric, or acetic acid, as specified by the purchaser, a 1 N[4] acid solution shall be used.

Test Specimens

6. (*a*) Whenever possible, the specimens intended for these tests shall be selected from pipe that previously have been broken in the strength test. Specimens shall be sound with all edges freshly broken, free of cracks or shattered edges, about 2 in. square, weighing not more than 200 g., and shall be thoroughly cleaned with a wire brush.

(*b*) A test shall be made on at least one specimen cut from each size of pipe. The results shall be reported separately for each individual specimen.

Weighing Apparatus

7. The balance used in weighing the specimen shall be sensitive to 0.01 g. when loaded with 200 g.

Procedure

8. (*a*) The specimens to be tested shall be dried to constant weight at a temperature between 210 and 230 F.

(*b*) The specimens, upon reaching constant weight, shall be suspended and completely immersed in the test solution at a temperature between 70 and 90 F. for a period of 48 hr., then removed from the solution and carefully and thoroughly washed with hot water, allowing the washings to run into the solution in which the specimen was immersed. The solution shall be filtered and the filter washed with hot water, adding the washings to the filtrate. To the filtrate shall be added 5 ml. of H_2SO_4 (sp. gr. 1.84). The solution shall then be evaporated (avoiding loss by spattering) to about 5 ml., transferred to a porcelain crucible (previously ignited to constant weight), and heated cautiously to dryness. The residue shall then be ignited to constant weight.

Calculation

9. The percentage of acid-soluble matter shall be calculated as follows:

$$\text{Acid-soluble matter, per cent} = \frac{R}{W} \times 100$$

where:

R = weight of the residue in the porcelain crucible, and

W = weight of the dry specimen before immersion.

Acceptance or Rejection

10. When the test for resistance to action of acids is specified, the pipe of each size and shipment shall be acceptable only when the percentage of acid-soluble matter for specimens representing such pipe does not exceed 0.25 per cent.

PHYSICAL TEST REQUIREMENTS

Crushing Strength Tests

Test Specimens

11. (*a*) The specimens for purpose of Tests shall be sound, full-size pipe and shall be selected by the purchaser or his representative at the point or points designated by him when placing the order.

(*b*) The manufacturer or seller shall furnish, without charge, specimens for tests, up to 0.5 per cent of the number of pipe in each size furnished except that in no case shall less than two specimens be furnished.

Measurement and Observation of Specimens

12. (*a*) The specimens shall first be freed from all visible moisture. When dry, each specimen shall be measured

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[4] These 1 N solutions should contain, respectively, 36.5, 63, 49, and 60 g. of the acid per liter of solution. For the purpose of these tests the solution can be prepared by taking the following volumes of acid and diluting to 1 liter: H_2SO_4 (sp. gr. 1.84), 28.5 ml.; HCl (sp. gr. 1.18), 88.9 ml.; HNO_3 (sp. gr. 1.42), 65 ml.; and glacial acetic acid (sp. gr. 1.05), 57.7 ml.

and inspected. The results of these observations shall be recorded.

(*b*) *Defective Specimens.*—Specimens that are observed to have fire cracks or other defects in form or dimensions in excess of the limits permitted in these specifications, shall be discarded and replaced with additional specimens from the shipment.

Test Bearings

13. Pipe shall be tested for crushing strength by either the three-edge-bearing method or by the sand-bearing method as described in Sections 16 and 17. Either of the two specified bearing methods shall be used on retests as provided for in Section 22 (*b*) and (*c*).

Apparatus and Application of Load

14. (*a*) Any prime mover or hand power device that will apply the load at a uniform rate of about 2000 lb. per min. or in increments of not more than 100 lb. at the same rate, may be used in making the test.

(*b*) The center of the load shall be applied to the top bearing block at a point distant from the spigot end of the pipe equal to one half of the overall length of the pipe. The upper bearing block shall be at the center line of the 200 deg. unperforated arc (see Section 24). The test load shall be applied to the upper bearing block in such a way as to leave the bearing free to move in a vertical plane passing midway between the lower bearings. In testing pipe that is "out of straight," the lines of the bearings chosen shall be from those which appear to give most favorable conditions for fair test.

(*c*) The pipe shall be allowed to stand under load no longer than is required to apply the load and to observe and record it.

(*d*) The testing machine shall be substantial and rigid throughout, so that the distribution of the load will not be affected appreciably by the deformation or yielding of any part. The bearings shall be sufficiently rigid to transmit and receive uniform loads throughout their lengths without deflection, and shall be so attached to the machine as to transmit and receive the maximum loads produced by the tests without lost motion, vibration, or sudden shock.

(*e*) The bearings and the specimen shall be accurately centered so as to secure a symmetrical distribution of the loading on each side of the center of the pipe in every direction.

(*f*) The load shall be applied until the pipe yields by cracks passing through the shell. At the discretion of the inspector the loading may be stopped before rupture of the pipe, provided the load is at least equal to the required average strength of the pipe.

Calculation and Report

15. The crushing strength shall be calculated by dividing the breaking load or applied load, as provided in Section 14 (*f*), by the net inside length of the barrel of the pipe, measuring from the bottom of the socket to the end of the spigot. The individual results of the tests of pipe of each size or each shipment shall be tabulated separately so as to show the percentage that fails to conform to the requirements of each test.

Three-Edge-Bearing Method

16. When the three-edge-bearing method is used, the ends of each specimen of pipe shall be accurately marked in halves of the circumference prior to the test. The lower bearings shall consist of two wooden strips with vertical sides having their interior top corners rounded to a radius of approximately $\frac{1}{2}$ in. The strips shall be straight and shall be securely fastened to a rigid block at least 6 by 6 in. in cross-section. The interior

vertical sides of the strips shall be parallel and spaced a distance apart of 1 in. per foot of pipe diameter, but in no case less than 1 in. Before the pipe is placed, a fillet of plaster of Paris or other equalizing material, such as sand and sulfur, thick enough to compensate for the inequalities of the pipe barrel, shall be cast on and between the lower bearings. The pipe shall be placed on the fillet while the Plaster of Paris is still somewhat plastic; the use of the plaster of Paris fillet may be dispensed with when agreeable to the manufacturer and the purchaser. The upper bearing shall be a rigid wooden block at least 6 by 6 in. in cross-section straight and true from end to end. A fillet of plaster of Paris thick enough to compensate for the inequalities of the pipe barrel shall also be cast along the length of the crown. The upper bearing shall be brought in contact while the plaster of Paris is still somewhat plastic. The upper and lower bearings shall extend the full length of the pipe exclusive of the socket.

Sand-Bearing Method

17. (*a*) When the sand-bearing method is used, the ends of each specimen of pipe shall be accurately marked in quarters of the circumference prior to the test. Specimens shall be carefully bedded in sand, above and below, for one fourth the circumference of the pipe measured on the middle line of the barrel. The depth of the bedding above and below the pipe at the thinnest points shall be one half the radius of the middle line of the barrel.

(*b*) The sand used shall be clean and moist and shall be such as will pass a 4760-micron (No. 4) sieve conforming to the requirements of the Standard Specifications for Sieves for Testing Purposes (A.S.T.M Designation: E 11).[5] The sand in the lower bearing shall be loose when the pipe is placed.

(*c*) The top bearing frame shall not be allowed to come in contact with the pipe nor with the top bearing plate. The upper surface of the sand in the top bearing shall be struck off level with a straightedge and shall be covered with a rigid top bearing plate, the lower surface of which is a true plane, made of heavy timbers or other rigid material, capable of distributing the test load uniformly without appreciable bending. The test load shall be applied at the exact center of this top bearing plate, in such a manner as to permit free motion of the plate in all directions. For this purpose a spherical bearing is preferred, but two rollers at right angles may be used.

(*d*) The test may be made without the use of a testing machine, by piling weights directly on a platform resting on the top bearing plate, provided, however, that the weights shall be piled symmetrically about a vertical line through the center of the pipe, and that the platform shall not be allowed to touch the top bearing frame.

(*e*) The frames of the top and bottom bearings shall be made of timbers so heavy as to avoid appreciable bending by the side pressure of sand. The interior surfaces of the frames shall be dressed. No frame shall come in contact with the pipe during the test. A strip of cloth may be attached, if desired, to the inside of the upper frame on each side, along the lower edge, to prevent the escape of sand between the frame and the pipe.

Absorption Test

Test Specimens

18. (*a*) The test specimens shall be sound pieces, of the full thickness of the barrel of the pipe, with all edges broken, and may be from pipe broken in the strength tests. They shall be from 12 to 20 sq. in. in area, and shall be as nearly

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[5] 1946 Book of A.S.T.M. Standards, Part II.

square as they can be readily prepared. They shall be free of observable cracks or shattered edges, and shall contain laminations and fissures only to the extent that these are representative of the pipe from which the specimens were taken.

(*b*) Each specimen shall be marked so that it may be identified with the pipe used in the strength test from which the specimen was taken. The marking shall be applied so that the pigment used shall cover not more than 1 per cent of the total superficial area of the specimen.

(*c*) One specimen shall be tested from each pipe broken in the strength test.

Weighing Apparatus

19. The balance used shall be sensitive to 0.5 g. when loaded with 1 kg., and weighings shall be read at least to the nearest gram. When other than metric weights are used, the same degree from accuracy shall be obtained.

Procedure

20. (*a*) The specimens shall be dried to constant weight in a drier or oven at a temperature of not less than 110 C. (230 F.).

(*b*) The dried specimens shall be placed in a suitable wire receptacle, packed tightly enough to prevent jostling, covered with distilled water or rain water, raised to the boiling point and boiled for 5 hr., and then cooled in water to a final temperature of 15 to 25 C. (59 to 77 F.). When cool, the specimens shall be removed from the water and allowed to drain for not more than 1 min. The superficial moisture shall then be removed by a towel or blotting paper, and the specimens immediately weighed.

Calculation and Report

21. The absorption of each specimen shall be calculated as percentage of the initial dry weight. The results shall be reported separately for each individual specimen, together with the average for all the specimens tested from the same shipment of pipe.

Acceptance or Rejection on Results of Tests

Crushing Strength and Absorption

22. (*a*) The crushing strength shall conform to the requirements prescribed in Table I and the absorption shall not exceed 8 per cent, except as provided in Paragraphs (*b*), (*c*), and (*d*).

(*b*) Failure of more than 20 per cent of the specimens of a size to conform to the requirements of the strength tests or the absorption tests or both shall result in rejection of all the pipe of that size in the shipment or delivery; except that in the event of 20 per cent of the specimens in any size failing to meet the requirements, the manufacturer or seller may, with the consent of the purchaser, furnish for test, without charge, additional specimens from the same shipment to be selected as specified in Section 11. In case more than 80 per cent of the specimens tested, including those first tested, shall show substantial conformance for each of the various tests performed, then the entire shipment or delivery for this size shall be accepted; otherwise it shall be rejected.

TABLE I.—CRUSHING STRENGTH REQUIREMENTS FOR STANDARD STRENGTH PERFORATED CLAY PIPE.

Size, in.	Average Strength, min., lb. per linear ft.	
	Three-Edge-Bearing Method	Sand-Bearing Method
4........	1000	1430
6........	1000	1430
8........	1000	1430
10........	1100	1570
12........	1200	1710
15........	1400	2000
18........	1700	2430
21........	2000	2860
24........	2400	3430

(*c*) However, in case of failure of pipe to conform to the strength requirements under the specified method, and the accuracy of the testing machine is questioned, a retest at the request of the manufacturer shall be made upon a machine whose accuracy is known, or the machine originally used shall be recalibrated before the retest is made.

(*d*) In addition to the requirements in Paragraph (*b*), failure of 10 per cent or more of the individual specimens tested to develop 75 per cent of the average crushing strength requirements shall be cause for the rejection of the shipment, but the manufacturer or seller may cull the pipe and submit the balance of the shipment for retest, and if the shipment then conforms to all of the requirements of these specifications it shall be accepted.

TABLE II.—DIMENSIONS OF STANDARD STRENGTH PERFORATED CLAY PIPE.

Size, in.	Laying Length		Maximum Difference in Length of Two Opposite Sides, in.	Outside Diameter of Barrel, in.		Inside Diameter of Socket at ½ in. Above Base, in.		Rows of Perforations	Perforations per row	Depth of Socket, in.		Thickness of Barrel, in.		Thickness of Socket at ½ in. from Outer End, in.	
	Nominal, ft.	Limit of Minus Variation,[a] in. per ft. of length		Min.	Max.	Min.	Max.			Nominal	Min.	Nominal	Min.	Nominal	Min.
4..	2, 2½, 3	¼	5⁄16	4⅞	5⅛	5¾	6⅛	4	7, 9, 11	1¾	1½	½	7⁄16	7⁄16	⅜
6..	2, 2½, 3	¼	⅜	7 1⁄16	7 7⁄16	8 3⁄16	8⅝	4	7, 9, 11	2¼	2	⅝	9⁄16	½	7⁄16
8..	2, 2½, 3	¼	7⁄16	9¼	9¾	10½	11	4	7, 9, 11	2½	2¼	¾	11⁄16	9⁄16	½
10..	2, 2½, 3	¼	7⁄16	11½	12	12¾	13¼	6	7, 9, 11	2⅝	2⅜	⅞	13⁄16	⅝	9⁄16
12..	2, 2½, 3	¼	7⁄16	13¾	14 5⁄16	15⅛	15¾	6	7, 9, 11	2¾	2½	1	15⁄16	¾	11⁄16
15..	3 , 4	¼	½	17 3⁄16	17 13⁄16	18⅝	19¼	6	10, 14	2⅞	2⅝	1¼	1⅛	15⁄16	⅞
18..	3 , 4	¼	½	20⅝	21 7⁄16	22¼	23	8	10, 14	3	2¾	1½	1⅜	1⅛	1 1⁄16
21..	3 , 4	¼	9⁄16	24⅛	25	25⅞	26¾	8	10, 14	3¼	3	1¾	1⅝	1 5⁄16	1 3⁄16
24..	3 , 4	⅜	9⁄16	27½	28½	29⅜	30⅜	8	10, 14	3⅜	3⅛	2	1⅞	1½	1⅜

[a] There is no limit for plus variation.

SIZES AND DIMENSIONS, WORKMANSHIP AND FINISH

Sizes and Dimensions

23. Pipe shall be furnished of the sizes and of the dimensions, including permissible variations, prescribed in Table II. When more than one length is permitted, the purchaser shall indicate, at the time of purchase, which lengths shall be furnished; unless so indicated, the manufacturer shall furnish such lengths as he may elect.

Perforations

24. Perforations shall be circular and cleanly cut, ¼ in. in diameter, arranged in rows parallel to the axis of the pipe. Perforations shall be approximately 3 in. center to center, along rows. The spigot end shall be unperforated for a length equal to the depth of socket. Rows shall be arranged in two equal groups on either side of the vertical center line of the pipe, and the total number of rows shall be as shown in Table II. The lowermost rows of perforations in each group shall be separated by an arc of 90 deg., and the uppermost rows of perforations in each group shall be separated by an arc of 200 deg. Spacing of rows between these limits shall be uniform.

Straightness

25. Pipes intended to be straight shall have a maximum ordinate as measured from the concave side of the pipe not to exceed ⅛ in. per foot of length.

Salt Glaze

26. The glaze shall consist of a continuous layer of salt glaze substantially free of large blisters or large pimples. Not

more than 10 per cent of the inner surface of any pipe barrel shall be bare of glaze except the socket, where it may be entirely absent. Glazing shall not be required on the outer surface of the barrel at the spigot end for a distance from the end of the pipe equal to the specified depth of socket. There shall be no well defined network of crazing lines or hair cracks.

Blisters

27. No blisters shall exceed 3 in. in diameter, and no blisters or pimples shall project more than $\frac{1}{8}$ in. above the surrounding surface of the pipe for sizes up to and including 18 in. in internal diameter. For sizes over 18 in. in internal diameter, no blisters shall exceed in diameter more than 2 in. per foot of the internal diameter of the pipe, nor project above the surrounding surface of the pipe more than $\frac{1}{8}$ in. per foot of the internal diameter of the pipe.

Finish of Ends

28. The ends of the pipes shall be square with their longitudinal axis, except as provided in Table II.

Marking

29. Each length of pipe over 6 in. in diameter shall bear the initials or name of the person, company, or corporation by whom manufactured, and the location of the plant. The markings shall be indented on the exterior of the pipe near the socket and shall be plainly legible for purpose of identification.

INSPECTION AND REJECTION

Inspection

30. All pipe shall be subject to inspection at the factory, trench, or other point of delivery by a competent inspector employed by the purchaser. The purposes of the inspection shall be to cull and reject pipe that, independent of the physical tests herein specified, fail to conform to the requirements of these specifications.

Rejection

31. Pipe shall be subject to rejection on account of any of the following:

(*a*) Variations in any dimension exceeding the permissible variations given in Table II,

(*b*) Fractures or cracks passing through the barrel or socket, except that a single crack at the spigot end of the pipe not exceeding 75 per cent of the depth of the socket, or a single fracture in the socket not exceeding 3 in. around the circumference nor 2 in. lengthwise may be permitted,

(*c*) Chips or fractures on the interior of the pipe exceeding 2 in. in length, 1 in. in width, and of a depth more than one fourth of the thickness of the shell,

(*d*) Blisters that are broken or exceed the dimensions specified in Section 27,

(*e*) Fire cracks or hair cracks sufficient to impair the strength, durability, or serviceability of the pipe,

(*f*) Variation of more than $\frac{1}{8}$ in. per linear foot in alignment of a pipe intended to be straight,

(*g*) Glaze that does not conform to the requirements specified in Section 26, and

(*h*) Perforations having diameters greater than $\frac{5}{16}$ in. or less than $\frac{3}{16}$ in.

Marking of Rejected Specimens

32. All pipe accepted may be plainly marked by the inspector. Rejected pipe shall not be marked or defaced so as to impair their value, but shall be replaced by the manufacturer or seller with pipe that meets the requirements of these specifications, without additional cost to the purchaser.

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